International Tax and Public Finance, 3: 397–412 (1996)

Fiscal Externalities and the Design of Intergovernmental Grants

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Abstract

This paper describes the tax and expenditure externalities that can occur in a federation, focusing on the (relatively neglected) vertical tax and expenditure externalities which arise when state governments' tax and expenditure decisions affect the federal government's budget constraint and vice versa. Formulas are derived for matching grants which correct the distortions in governments' decision-making caused by fiscal externalities. With vertical tax externalities, the matching revenue grant may result in transfers from the state government to the federal government. With vertical expenditure externalities, the federal government should provide a matching expenditure grant equal to the additional federal revenue that is generated from an additional dollar spent by a state on productivity-enhancing activities such as education.

Keywords: fiscal federalism, fiscal externalities, intergovernmental grants, tax exporting, tax competition.

The normative theory of public finance is largely based on the Diamond and Mirrlees (1971) model of optimal taxation and the Atkinson and Stern (1974) model of optimal public expenditures. Most models of optimal taxation and expenditure have been developed within the context of a centralized state, and the implications for a federal state have received relatively little attention. See Wiegard (1980), Gordon (1983), and Wildasin (1984) for analysis of fiscal federalism within an optimal tax framework, and Shah (1994) for a recent survey of the intergovernmental fiscal relations, especially in regard to developing and emerging market economies.

This paper explores the design of intergovernmental grants, focusing on the distortions in governments' fiscal policies caused by fiscal externalities. Fiscal externalities lead to non-optimal tax and expenditure decisions if governments have biased perceptions of the total marginal cost of raising tax revenues and total marginal benefit from their expenditures. Matching revenue and expenditure grants from the central government can be used to correct the biases in state governments' decisions. In Section 1, I describe the circumstances in which fiscal externalities can occur in a federation. I distinguish between tax and expenditure externalities and between direct horizontal and indirect horizontal and vertical externalities. The latter, which have received relatively little attention in the academic literature, are described at greater length. In Section 2, I derive general formulas for the revenue matching and expenditure matching grant rates when there are tax and expenditure externalities in a federation. I also briefly describe the lump-sum grants which are required to equalize the social marginal cost of public funds across governments in a federation. The final section contains my conclusions.

1. Fiscal Externalities

Fiscal externalities play an important role in the design of intergovernmental grants, and I will begin by discussing three basic types of fiscal externality. I will refer to the central government as the federal government and to the provincial, state, or local governments as the state governments. Interjurisdictional fiscal externalities occur when a government's tax and expenditure decisions affect the well-being of taxpayers in other jurisdictions either:

- directly by changing their consumer or producer prices or their public good provisions, or
- indirectly by altering the tax revenues or expenditures of other governments.[1]

What distinguishes the two types of fiscal externalities is that direct fiscal externalities affect the utility functions of non-residents whereas indirect fiscal externalities affect the budget constraints of other governments. Direct fiscal externalities are always horizontal, i.e. between state governments. Indirect fiscal externalities may be either horizontal or vertical, i.e. between the federal and state governments. Fiscal externalities can arise either through taxation or expenditure decisions, and they may be either positive (beneficial) or negative (harmful).

Horizontal fiscal externalities affect the fiscal performance of a federation if, as seems reasonable to assume, state governments do not take into account the effects of their taxation and expenditure decisions on the well-being of residents of other states or on the budget constraints of other state governments. Vertical fiscal externalities distort fiscal decisions if state government do not take into account the effects of their fiscal decisions on the tax revenues or expenditures of the federal government, or if the federal government ignores the impact of its fiscal decisions on the state governments. Whether the state and federal government take into account the effects of their fiscal decisions on the other level of government is an important behavioral issue which will be discussed in more detail in Section 2.1.

1.1 Tax Externalities

Table 1 gives examples of the three types of tax externalities. It should be noted, however, that a particular tax, such as a state sales tax, may generate all three types of externality. In describing how tax externalities affect fiscal behaviour of governments, I will focus on the implications for the marginal cost of public funds which can defined as the economic cost to taxpayers of raising an additional dollar of tax revenue.[2] It is assumed that governments select their mix of taxes and the overall level of taxation to fund public expenditures based, in part, on their perceived marginal cost of public funds (MCF). Tax externalities can distort their fiscal decisions if the perceived MCF deviates from the total or social marginal cost of public funds (SMCF) which takes into account the effect of a tax change on all taxpayers and on all governments' budget constraints.

A direct tax externality occurs when part of the tax burden is borne by individuals who do not reside in the jurisdiction which imposed the tax. For example, a hotel tax may be borne by visitors from other jurisdictions. Fujii, Kahled, and Mak (1985) estimated the elasticity of demand and supply for hotel accommodation in Hawaii to be -0.953 and 1.976

Table 1. Tax externalities.

Types of Externality	Examples	Fiscal Implications	Revenue Matching Grant Rate
Direct Horizontal	Tax Exporting: A hotel tax which is borne by visitors from other states	Increased reliance on taxes where at least part of the burden is borne by residents of other jurisdictions.	$-\frac{\sum_{k=1}^{n} X_i^k - X_i^i}{\sum_{k=1}^{n} X_i^k}$
Indirect Horizontal	Tax Competition: A sales tax which causes consumers to purchase the taxed commodities in another state.	The potential mobility of the tax base leads to downward pressure on tax rates.	$\frac{\sum_{k=1}^{n} R_{t_{ij}}^k - R_{t_{ij}}^i}{R_{t_{ij}}^i}$
Indirect Vertical	Tax Base Overlap: Federal and state excise taxes on cigarettes.	State governments, and possibly the federal government, will impose excessive tax rates on the shared tax base. Both levels of government could end up on the "wrong" side of the Laffer curve for total tax revenue.	$\frac{\tau_{0j}\epsilon_{jj}}{1 + \tau_{ij}\epsilon_{jj}}$

Where X_i^k is the quantity of the good taxed by state i and consumed by the residents of state k, R_{ij}^k is the change in total revenue in state k as a result of an increase in the tax on commodity j by state i, ϵ_{jj} is the elasticity of demand for commodity j, τ_{0j} is the federal ad valorem tax rate on commodity j, and τ_{ij} is the state advalorem tax rate on commodity j.

respectively. Using the conventional tax incidence model, they concluded that two-thirds of a Hawaiian hotel tax would be borne by non-resident consumers and that less than one third of the tax would be borne by residents of Hawaii because 45 percent of hotel rooms in Hawaii are owned by non-residents. Such tax exportation may cause state governments to underestimate the SMCF if they ignore the tax burdens which are borne outside of their jurisdiction. See Arnott and Grieson (1981) and Wildasin (1987).

An indirect horizontal tax externality can occur if tax bases are mobile between jurisdictions. For example, a sales tax may cause consumers to purchase the taxed commodities in another jurisdiction.[3] Stephenson and Hewett (1985, Tables I and II) found that the elasticity of Iowa's motor fuel tax revenue with respect to Missouri's motor fuel tax rate was 0.1080 and the elasticity of Missouri's motor fuel tax revenue with respect to Iowa's motor fuel tax rate was 0.1485. Tax base mobility will cause a subnational government to overestimate the SMCF for its mobile tax bases if it ignores the additional revenue that other jurisdictions obtain when it raises its tax rates. Tax competition with regard to mobile tax bases puts downward pressure on the revenues of subnational governments, leading to the inadequate provision of public services by these governments.[4]

While most of the theoretical literature is based on models of tax competition in which an increase in one state's tax rate leads to increases in the tax revenues of other states, the empirical study by Stephenson and Hewett (1985) found that income and sales tax increases by Iowa or Missouri *reduced* the total tax revenues of the other state. For example,

they found that the elasticity of Iowa's total income, sales, and motor fuel tax revenue was −0.08 with respect to Missouri's personal income tax rate and −0.221 with respect to Missouri's sales tax rate. The elasticity of Missouri's total income, sales, and motor fuel tax revenue was −0.108 with respect the Iowa's personal income tax rate and −0.038 with respect to the Iowa sales tax rate. An increase in a state's tax rate probably has a negative effect on other states' tax revenues because of the reduction in its residents' real after-tax income, causing a decline in imports from other states.

Most of the literature on tax externalities has focused on the horizontal externalities. Vertical tax externalities, which occur when a tax rate change by one level of government affects the tax revenues of the other government, have received relatively little attention. One example is the deductibility of state and local taxes from the federal income tax. Another example is tax base overlap which occurs when two government tax the same base. The taxation of cigarettes by the Canadian federal and provincial governments is an example of tax base overlap, and Figure 1 shows how this tax externality occurs. The demand curve for cigarettes in a province, D, is assumed to have a negative slope, and the supply curve, S, is assumed to be perfectly elastic. Initially, the federal excise tax rate is t_f^0, the provincial government's excise tax rate is $t_p{}^0$, and the consumer price is P^0. The federal tax revenue collected in the province is (area c + area e), and the provincial government's tax revenue is (area b + area d). The quantity of cigarettes consumed is X^0. If the provincial government raises its tax rate to t_p^1, the consumer price increases by the amount of the tax increase to P^1, and the provincial government's tax revenues (presumably) increase by (area a − area d). However, the federal government's tax revenues will decline by an amount equal to area e because the quantity consumed has declined to X^1.[5] Note that this situation is symmetric. An increase in the federal tax rate will reduce the provincial government's tax revenues.

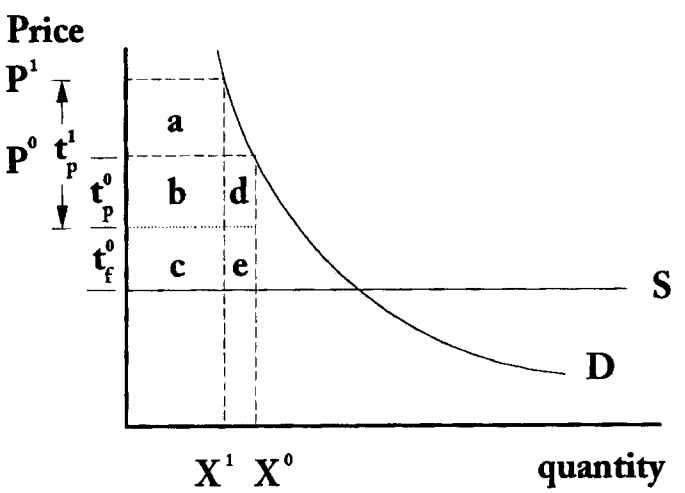

Figure 1. Tax base overlap.

If both levels of government neglect the revenue losses incurred by the other government when they make their taxation decisions, then both levels of government will underestimate the social marginal cost of raising tax revenue from the common tax base. See Johnson (1988) for a theoretical model of the potential biases in fiscal decisions caused by vertical tax externalities, and Boadway and Keen (1994) on the efficiency implications of tax base overlap.[6] The downward bias in the perceived marginal cost of public funds will lead both governments to levy a higher total tax rate on the shared tax base than they would if it was only taxed by one level of government. In this vein, Keen (1995) has developed a model of a federation in which the Leviathan governments wind up on the negatively-sloped section of the Laffer curve for total tax revenue.

Tax base overlap may be the public sector version of the common property resource problem that occurs in the private sector when property rights in a resource are not defined or enforceable. The over-exploitation of shared tax bases may be the public sector equivalent of the over-exploitation of fishing grounds. The common property resource problem created by tax base overlap is not widely appreciated. Hewitt and Mihaljek (1992, p. 346) stated that "no economic justification exists for prohibiting overlapping tax assignments, and in many countries different levels of government indeed use the same taxes without negative consequences." However, calculations by Dahlby (1994) indicate that it may be a very significant problem in Canada. All of the provincial governments, except Quebec, levy their personal income tax as a proportion of the basic federal income tax. (Quebec collects its own provincial income tax.) In addition to this basic provincial income rate, all of the provinces, except Newfoundland, levy a surtax on high income earners. The Dahlby study found that the perceived marginal cost of public funds for increases in the provincial governments' basic personal income tax rate ranged between 69 and 77 percent of the total social marginal cost of public funds. However, for an increase in the provinces' high income surtax, the perceived marginal cost of public funds was at most 36 percent of the total social marginal cost of public funds, and in three provinces Manitoba, Nova Scotia, and Prince Edward Island an increase in the provincial surtax rate would actually reduce total federal and provincial tax revenues if the uncompensated labour supply elasticity is 0.1. The bias in the marginal cost of public funds caused by tax base overlap may explain why the Canadian provinces have introduced high income surtaxes, and therefore impose more progressive income tax rate structures than the federal government, when the conventional wisdom holds that tax competition for mobile high income taxpayers will cause the provinces to have less progressive income tax rate structures.

1.2 Expenditure Externalities

Table 2 shows examples of the three basic types of expenditure externality. The classic example of a direct horizontal expenditure externality is pollution abatement by one state which benefits the residents of another state by lowering cross-border emissions. An example of an indirect horizontal expenditure is a economic development grant provided by a state which attracts investment that would otherwise have occurred in other states, thereby reducing the tax bases of the other states. An indirect vertical expenditure externality occurs when the expenditure decisions by one level of government affect the expenditures or

Table 2. Expenditure externalities.

Types of Externality	Examples	Fiscal Implications	Expenditure Matching Grant Rate
Direct Horizontal	Benefit Spillovers: Pollution abatement activity which benefits the downstream residents of other states.	Under-provision of activities which generate beneficial externalities.	$\sigma_{g_i}(1 - \rho_{g_i})$
Indirect Horizontal	Spending Competition: Economic development grants which attract investment that would otherwise have occurred in other states.	Over-provision of activities which reduce the tax revenue of other state governments.	$\rho_{g_i} - \rho^i_{g_i}$
Indirect Vertical	Expenditure Interdependence. State education expenditures which increase the federal government's income, payroll, and sales tax revenues because of the increase in students' lifetime earnings.	Under-provision of activities which have a positive effect on the net revenues of other levels of government.	$\tau_0 \phi(g_i)(1 + \eta)$

Where σ_{g_i} is the fraction of the direct benefits from the provision of a public service by state i which accrue to non-residents, ρ_{g_i} is the additional revenue that accrues to all governments from an additional dollar spent on the public service by state i, ρ^i_g is the additional revenue that accrues to state state i when is spends an additional dollar on the public service, τ_0 is the federal tax rate on labor income, $\phi(g_i)$ is the increase in the wage rate when an additional dollar is spent on g_i by state i, and η is the uncompensated labor supply elasticity.

revenues of the other level of government. An important Canadian example is the interdependence between the federal government's provision of unemployment insurance (UI) benefits and the provinces' welfare programs. If the federal government reduces the level or duration of UI benefits, more people will apply for welfare, and it has been estimated that the provinces' spending on social assistance increases by $0.30 for each $1.00 in UI payments. Conversely, short-term employment programs by the provinces, which allow unemployed welfare recipients to qualify for unemployment insurance benefits, ultimately lead to higher UI spending by the federal government.

Vertical expenditure externalities can also occur through their effect on the revenues of the other level of government. For example, spending by a state government on education or physical infrastructure raises the potential earnings of its residents by making them more productive, and this will increase the federal government's income, payroll, and sales tax revenues.[7] The under-provision of a state activity which generates a positive vertical expenditure externality is illustrated in Dahlby (1995).

2. A Model of Intergovernmental Grants

It is assumed that there is a constitutionally defined assignment of expenditure responsibilities and tax powers for each level of government. The optimal intergovernmental grants

will be derived given this tax and expenditure assignment. While I take the tax and expenditure assignment as given in deriving the optimal intergovernmental grants, in some cases it may be better to re-assign tax powers or expenditure responsibilities rather than try to design a system of grants that will make an unsatisfactory tax and expenditure assignment function properly.

Suppose there are n state governments in a federation. It is assumed that all of the individuals within a given state are identical, and therefore intra-state distributional concerns are not addressed in this model. For simplicity, it is assumed that all states have the same population, normalized to equal one. The well-being of the representative individual in state $i = 1, \ldots, n$ will be reflected by the indirect utility function $V^i(q, g, z)$ where q is a vector of consumer prices for the goods purchased by the individual, g is a vector of public goods supplied by governments, and z is the individual's lump-sum income. To simplify the presentation of the model, it is assumed that producer prices are fixed. However, it should be recognized that a state's tax and expenditure decisions can generate fiscal externalities by altering the producer prices received by the residents of other states. To help remedy this limitation of the model, the revenue matching grant required to correct the fiscal externality caused by tax exporting is derived in Section 2.1 within the context of a model in which producer prices are variable and the producers of the taxed good may be residents of other states.

Let t_i denote a vector of commodity tax rates imposed by state i, and g_i denote the public good provided by state i. Let the federal tax rates be t_0 and the federal public good be g_0. The tax revenue generated by state i, R^i, will, in general, be a function of the tax rates and public goods provided by all of the governments in the federation:

$$R^i = R^i(t_0, t_1, \ldots, t_i \ldots, t_n; g_0, g_1, \ldots, g_i \ldots, g_n) \tag{1}$$

Let R^k_{tij} and R^k_{gi} denote the partial derivatives of state k's tax revenue function with respect to state i's tax rate on tax base j and state i's provision of its public good. The effects of changes in t_{ij} and g_i on the total revenues of all governments will be denoted as:

$$R_{t_{ij}} = \sum_{k=0}^{n} R^k_{t_{ij}}; \; R_{g_i} = \sum_{k=0}^{n} R^k_{g_i} \tag{2}$$

Alternative fiscal regimes are evaluated according to the following social welfare function:

$$S = S(V^1, \ldots, V^i, \ldots, V^n) \tag{3}$$

It is assumed that S is concave and increasing in V^i. Let the social value of an additional dollar of lump-sum income received by the representative individual in state i be $\beta^i = S_i\lambda^i$ where $S_i > 0$ is the partial derivative of S with respect to V^i, and λ^i is the marginal utility of income of the representative individual in state i. It will be convenient to assume that the β^is are normalized so that $\beta^i = 1$ at the average income in the federation. The social valuation of increases in t_{ij} and g_i will be denoted as follows:

$$S_{t_{ij}} = \sum_{k=1}^{n} \beta^k \frac{V^k_{t_{ij}}}{\lambda^k}\,;\; S_{g_i} = \sum_{k=1}^{n} \beta^k \frac{V^k_{g_i}}{\lambda^k} \tag{4}$$

where $V^k_{t_{ij}}$ and $V^k_{g_i}$, represent the direct effect of an increase in state i's tax rate or public good provision on its residents of state k. We will begin our analysis by considering the intergovernmental grants that are required to internalize tax externalities in a federation.

2.1 Revenue Matching Grants

The taxation decisions made by state i will depend on the state's perceived marginal cost of public funds from raising additional tax revenue, MCF. It is assumed that in calculating its MCF, a state government ignores the impact of its taxes on the well-being of the residents of other states or on the tax revenues collected by other states or the federal government. Thus the MCF for state i in raising an additional dollar of tax revenue from increasing its tax rate on commodity j is:

$$MCF_{t_{ij}} = -\frac{1}{\lambda^i}\frac{V^i_{t_{ij}}}{R^i_{t_{ij}}} \tag{5}$$

The social marginal cost of an increase in tax revenue when state i increases its tax rate on tax base j is:

$$SMCF_{t_{ij}} = -\frac{S_{t_{ij}}}{R_{t_{ij}}} \tag{6}$$

Thus the $SMCF_{t_{ij}}$ incorporates the direct effects of the tax increase on all individuals, and their indirect effects via the changes in the tax revenues of all governments.

A state's perceived $MCF_{t_{ij}}$ will not equal its $SMCF_{t_{ij}}$, and its taxation decisions will be "biased," if:

- changes in t_{ij} directly affect the well-being of individuals outside state i, i.e. $(1/\lambda^i)V^i_{t_{ij}} \neq S_{t_{ij}}$;
- changes in t_{ij} affect the revenues of the other governments (including the federal government), i.e., $R^i_{t_{ij}} \neq R_{t_{ij}}$;
- changes to t_{ij} have socially relevant distributional consequences i.e. some $\beta^k \neq 1$.

A revenue matching grant, at the rate $m_{t_{ij}}$, can be designed to equate $MCF_{t_{ij}}$ with $SMCF_{t_{ij}}$ as follows:

$$\frac{-\left(\frac{1}{\lambda^i}\right)V^i_{t_{ij}}}{(1 + m_{t_{ij}})R^i_{t_{ij}}} = \frac{-S_{t_{ij}}}{R_{t_{ij}}} \tag{7}$$

or:

$$m_{t_{ij}} = \left(\frac{(\lambda^i)^{-1} V^i_{t_{ij}}}{S_{t_{ij}}}\right)\left(\frac{R_{t_{ij}}}{R^i_{t_{ij}}}\right) - 1 \tag{8}$$

With the optimal revenue matching grant, state i will evaluate its tax mix according to the appropriate SMCFs. The revenue matching rate defined in the above equation will apply to state i's revenues from taxing commodity j. This assumes that state i's tax revenue from its other tax sources are unaffected by changes in t_{ij}. This is obviously a strong assumption since changes in one tax rate by state i will often affect its tax revenues from other sources. When these interactions are non-zero, a more complicated formula is required to calculate the optimal revenue matching rate.

The revenue matching rate will tend to be positive if an increase in t_{ij} generates additional revenue for other governments and negative if an increase in t_{ij} adversely affects the residents of other jurisdictions through higher consumer prices (or lower producer prices in the most general case).

Table 1 shows the revenue matching grant rates for the three forms of tax externality in the absence of distributional concerns, i.e. $\beta^i = 1$ for all i. Under the assumption of fixed producer prices, the revenue matching rate with tax exporting should be equal to the (negative) fraction of the taxed good that is consumed by residents of other states. When producer prices are not fixed, the matching rate formula can be shown to equal the following:

$$m_i = \frac{\eta X^i_c - (1 - \tau_i)\epsilon X^i_p}{\eta X_c - (1 - \tau_i)\epsilon X_p} - 1 \tag{9}$$

where τ_i is the ad valorem tax rate on the commodity imposed by state i, $\epsilon \leq 0$ and $\eta \geq 0$ are the elasticities of demand and supply of the taxed commodity in state i, X^i_p and X^i_c are the quantities of taxed commodity produced and consumed by the residents of state i, X_p and X_c are the quantities of the commodity taxed by state i which are produced and consumed by the residents of all states. If the tax is entirely borne by producers because either $\eta = 0$ or $\epsilon = -\infty$, then $m_i = -(X_P - X^i_P)/X_p$ or minus the out-of-state producers' share of total domestic production. If all of the taxed commodity is produced by out-of-state producers, $X^i_p = 0$ and $X_p = X_c$, and all consumption of the commodity is by residents of the state, $X^i_c = X_c$, then the matching rate is $-(1 - \tau)\epsilon/(\eta - (1 - \tau)\epsilon)$ or minus the fraction of the tax burden that is shifted to out-of-state domestic producers through lower producer prices. Note that if some of the commodity is supplied by imports from foreign producers, $X^i_c = X_c > X_p$, then the matching rate goes to zero as the ratio X_c/X_p becomes large. Thus matching rate is not imposed if a state's taxes are shifted to foreign producers (or foreign consumers).

The matching grant rate required to correct the fiscal externality caused by a hotel tax in Hawaii can be calculated using the demand and supply elasticities for hotel accommodation obtained by Fujii, Kahled, and Mak (1985), their estimate that U.S. visitors represented 65 percent of total visitors to Hawaii in 1980, and their estimate that 45 percent of hotels rooms in Hawaii are owned by non-residents. Given these parameter estimates, the matching rate for a hotel tax in Hawaii is -0.77.[8] In other words, the state of Hawaii would

be required to remit to the federal government over three quarters of the hotel tax revenue in order to correct the potential bias caused by tax exporting.

With tax competition, the revenue matching rate is the additional revenue that accrues to the other states when state i raises an additional dollar of tax revenue from taxing commodity j.[9] The computation of this matching rate requires the estimation of the responsiveness of other states' tax bases to changes in a given state's tax rate. As noted in Section 1.1, Stephenson and Hewett (1985) have estimated a model of the interaction of state tax revenues and tax rates in the United States. Their results indicate that a \$1.00 increase in Iowa's tax revenue due to an income tax increase would reduce Missouri's income, sales and motor fuel tax revenue by \$0.195, and a \$1.00 increase in Iowa's tax revenue due to a sales tax increase would reduce Missouri's income, sales and motor fuel tax revenue by \$0.077. Conversely, a \$1.00 increase in Missouri's tax revenue due to an income tax increase would reduce Iowa's income, sales and motor fuel tax revenue by \$0.307, and a \$1.00 increase in Missouri's tax revenue due to a sales tax increase would reduce Iowa's income, sales and motor fuel tax revenue by \$1.86. All of these horizontal indirect tax externalities are large, and the last one seems to implausible. More econometric studies along the lines of the Stephenson and Hewett paper are clearly required to gain a clearer understanding of the direction and magnitude of the externalities.

With tax base overlap, the matching rate will usually be negative and equal to the reduction in federal tax revenues when state i raises an additional dollar to tax revenue from their common tax base. If an increase in the tax rate on commodity j does not affect the demand for any other taxed commodity, then the matching rate formula is given in Table 1 where $\epsilon_{jj} < 0$ is the own price elasticity of demand for commodity j, τ_{0j} is the federal ad valorem tax rate on commodity j, and τ_{ij} is the state ad valorem tax rate on commodity j. For example, if the federal and state ad valorem tax rates are 0.35 and the own-price elasticity of demand for the taxed commodity is -0.5, then the state should turn over 21 percent of its tax revenues to the federal government.

Boadway and Keen (1994) have analyzed tax base overlap in the context of a model where federal and state governments impose taxes on labour income (individuals' labour supply elasticities are positive and individuals are immobile between states) and share in the rents generated a fixed factor of production. They derive optimal lump-sum transfer between the two levels of government in two contexts a model in which the federal government is Stackelberg leader and the states are Nash followers and a model in which both levels of government behave as Nash competitors. In the Stackelberg leader model, the federal government chooses its tax rate, its public good provision, and the lump-sum transfer to maximize the utility of a representative individual subject to the federal government's budget constraint and the states' reaction functions which describe the states' tax rates as a function of the federal government's fiscal variables. In this context, they show that the federal government can implement a lump-sum transfer and tax level which corrects the tax base overlap problem. In certain configurations of the model, this is a transfer from the states to the federal government, creating a negative fiscal gap for the states in the sense that their revenues exceed their own purposes expenditures which is contrary to the fiscal positions of state governments in most federations. When both levels of government behave as Nash competitors, Boadway and Keen show that transfers between the two levels of government will be welfare improving (although the direction of the transfer is ambiguous), but the existence

of such transfers is problematic, given the assumption of Nash behaviour by both levels of government. However, it might be argued that transfers would be instituted when the constitution of the federation, which specifies the taxing powers and expenditure responsibilities of the two levels of government, was established.

Clearly, the efficiency implications and the existence of transfers which will offset the potentially distorting effects of vertical tax externalities depend on whether each level of government takes into account the effects of its tax policies on the other level of government. First, consider the behaviour of state governments within the context of a median voter model. It seems reasonable to assume that a state government would ignore the impact of its tax policy on the federal government if the state government's share of the federal tax base is small, and therefore its impact on the federal government's fiscal decisions will be small. However, in some federations some states are relatively large. For example, 40 percent of the Canadian federal government's revenues are raised in Ontario, and tax policy in Ontario may have a noticeable effect on federal tax revenues. The relative size of a state may affect their tax policy with regard to tax bases which are shared with the federal government.

Would a federal government necessarily take into account the states' responses to its tax rates? Suppose that the federal government's tax policy is determined by the median voter in state i. A rationale well-informed voter in state i would take into account how the federal taxes affect state i's budget constraint, but would probably not be concerned with the effect of the federal government's tax policy on other states. Thus the federal government may have Nash behaviour with respect to the tax policies of other states. Thus, it is far from clear what is the appropriate framework within which to analyze the tax rate determination with tax base overlap, and empirical analysis of federal and state tax behaviour may help to determine which model is appropriate.

To this point, the effect of distributional concerns on the revenue matching grants have been ignored. In the simplest case where there is no tax externalities, the revenue matching rate would equal $(1/\beta^i) - 1$. Thus the matching rate would be negative for the states where social marginal utility of income is high, i.e. states with below average income. Although it seems perverse to take tax revenue away from low income states and transfer it to high income states, the revenue matching grant is meant to correct the states' perception of the social cost of raising additional tax revenue, and the other components of the grant system, to be discussed below, will in general offset these seemingly inequitable transfers.

2.2 Optimal Equalization Grants

The revenue matching grants, described in Section 2.1, were designed so that each state government would choose the correct tax mix because it would evaluate the cost of raising revenue from each of its tax sources according to the correct SMCF for that tax base. However, these matching grants will not, in general, ensure that the SMCF is the same for all governments in a federation. Gordon (1983, p. 583) was the first to pointed out the need for a "direct income transfer" in order to achieve an optimal allocation of the tax burden within a federation. Implicit in Gordon's discussion is the notion that lump-sum inter-governmental transfers are required to equalize the SMCF across all of the governments in a federation, a condition which characterizes an optimal fiscal system.[10]

The rationale for optimal equalization grants and their general characteristics were recently described in Dahlby and Wilson (1994), and because of the constraint on the length of this paper they will not be discussed in detail. However, the following general points should be noted:

- The optimal equalization grants are, in general, required to achieve distributional equity in a federation which relies on distortionary taxes. If there are differences in the SMCF across different governments in a federation, then a net social gain can be achieved in equalizing the SMCFs by adjusting the level of taxation across the governments. This will result in gains to taxpayers in recipient states and losses to taxpayers in net contributing states.
- The optimal equalization grants will, in general, depend on the elasticities of the tax bases and the tax rates of the governments in a federation as well as the federation's distributional goals. The distributional goals of the federation cannot be achieved solely by federal grants to persons because reliance on distortionary taxation means that a dollar in the hands of the low income taxpayer is worth less than a dollar in the hands of the low income taxpayers' state government.
- The optimal equalization grants are lump-sum intergovernmental grants which can take the form of inter-state transfers or federal-state transfers.

2.3 Expenditure Matching Grants

I will now consider the matching grants that are required to correct expenditure externalities. Direct benefit spillovers by state governments have traditionally provided a rationale for matching expenditure grants from a central government. If expenditures are financed by non-distortionary lump-sum taxes, then the federal government should provide state i with an open-ended matching grant, where the matching rate, m_{gi}, is equal to the fraction of the direct benefits which accrue to individuals outside of state i.[11] With distortionary taxation, the matching expenditure grant should reflect both the direct and indirect benefit spillover rates.

The optimal provision of a public good by state i is given by the following version of the Atkinson and Stern (1974) condition:

$$S_{g_i} = SMCF\,(c_i - R_{g_i}) = SMCF\,(1 - \rho_{g_i})c_i \tag{10}$$

where S_{g_i} is the total direct benefit to the residents of all states, R_{g_i} is the change in revenue to all governments from an additional unit of the public good provided by state i, and c_i is the marginal cost of g_i. It is also convenient to express this condition in terms of ρ_{g_i}, the change in total revenue per dollar spent on g_i. SMCF is the social marginal cost of funds. This formulation of the optimality condition is based on the assumption that there is a system of matching revenue grants and lump-sum equalization grants discussed in Sections 2.1 and 2.2 which equalizes the SMCF across all jurisdictions. The revenue effects of the public good can be viewed as reducing the net expenditure that has to be financed through distortionary taxation or as an additional benefit of the public good which has a

shadow price given by the SMCF. With the revenue matching and equalization grants, the revenue effects of the increase in g_i are all valued at the SMCF, which is the same for all governments.

It is assumed that state i ignores the direct benefit spillovers and the indirect revenue spillovers when it makes its expenditure decisions. Let $V^i_{g_i}$ be the direct benefit to the residents of state i, and $\rho^i_{g_i}$ be the additional revenue to state i from an additional dollar spent on g_i. State i determines its provision of the public good according to the following version of the Atkinson-Stern condition:

$$(\lambda^i)^{-1} V^i_{g_i} = SMCF\ (1 - m_{g_i} - \rho^i_{g_i})c_i \tag{11}$$

where m_{g_i} is the matching rate for an expenditure grant provided by the federal government. The fraction of the direct benefits that accrue to individuals who reside outside i is:

$$\sigma_{g_i} = \frac{S_{g_i} - (\lambda^i)^{-1} V^i_{g_i}}{S_{g_i}} \tag{12}$$

The matching rate is set so that state i will provide the optimal public good as defined in equation (10), and it is equal to the following:

$$m_{g_i} = \sigma_{g_i}(1 - \rho_{g_i}) + (\rho_{g_i} - \rho^i_{g_i}) \tag{13}$$

Thus the formula for the optimal expenditure matching rate has two terms. The first term is the direct benefit spillover rate multiplied by the net amount that has to be financed through distortionary taxes by all governments. The second term is the net revenue spillover per dollar of expenditure on the public good. Table 2 shows the matching rate formula for the three types of expenditure externality. The matching rate with a direct horizontal benefit spillover is the fraction of the direct benefits that accrue outside state i multiplied by the net tax revenue that is required to finance an additional dollar spent on the good. If all government expenditures were financed by non-distortionary lump-sum taxes, then $\rho_{g_i} = \rho^i_{g_i} = 0$ and $m_{g_i} = \sigma_{g_i}$, which is the conventional result. If expenditure on a local public good does not generate revenue spillovers, $\rho_{g_i} = \rho^i_{g_i}$, then the matching rate will be greater than (less than) the fraction of the direct benefits that accrue to the residents of other states if spending on the good reduces (increases) the state's tax revenues. On the other hand, if there are no direct benefit spillovers, $\sigma_{g_i} = 0$, then the matching expenditure rate should equal the revenue spillover rate, i.e. the additional revenue that accrues to other states for each dollar spent on the good by state i.

The possibility of a vertical revenue spillover is especially important in some federations if state governments control spending on infrastructure and education which will increase the productivity of labour and therefore increase the federal government's tax revenues. The federal matching rate for productivity-enhancing expenditures should be the additional tax revenue that accrues to the federal government when the state spends an additional dollar on that activity.[12] Note that this provides a rationale for federal matching grants for state education expenditures which does not depend on equity arguments or inter-state mobility of educated workers.

Finally, the expenditure matching grants would be affected by distributional weights, the β^i. If there were no expenditure externalities, then the expenditure matching rate would be $1 - (1/\beta^i)$, which would be larger for states where the social marginal benefit of a dollar is higher.

3. Conclusion

This paper has explored the design of intergovernmental grants from the perspective of optimal tax/expenditure theory. I have investigated the conditions under which:

- a state's marginal cost of public funds may differ from its social marginal cost because of tax externalities;
- a state's expenditure decisions may deviate from the socially optimal level because of expenditure externalities;
- the state and federal governments may have different SMCFs.

Matching revenue, matching expenditure, and equalization grants can be devised which correct these departures from the optimal fiscal system. While this approach to fiscal federalism is not new, I feel that it has not been fully exploited.

While I obviously feel that the optimal tax/expenditure approach can make important contributions to the study of fiscal federalism, I am also aware of its limitations. The measurement of the marginal cost of public funds for the federal and state governments and the fiscal externalities that they generate are crucial to the implementation of the model, but very difficult to measure. Economists have for the most part tried to measure the marginal cost of funds for various taxes by specifying theoretical models and then calculating the MCFs based on prevailing views about the magnitudes of the key parameters of the underlying model. While more useful research can be done in this vein, it would also be useful to explore an alternative approach based on econometric estimates of the elasticity of tax revenue with respect to tax rates. This elasticity is the key component of the calculation of the MCF. Econometric estimation of these elasticities, using time series and cross-section data for state government revenues such as in the Stephenson and Hewett (1985) study, would greatly improve the accuracy of the MCF calculations and provide estimates of the indirect fiscal externalities.

Acknowledgments

This paper is based on portions of Dahlby (1995), a report prepared for the Policy Research Department of the World Bank, and ongoing research on tax assignment in a federal state with my colleague Sam Wilson. I would like to thank the anonymous referees for their helpful comments.

Notes

1. In this paper, I focus on intergovernmental fiscal externalities and not the intra-jurisdictional fiscal externalities that arise in models with mobile labor and public goods. See for example Boadway and Flatters (1992). Mintz and Tulkens (1986, p. 148) classify fiscal externalities as having a "private consumption effect" and

a "public consumption effect." Their taxonomy corresponds to my classification of direct and indirect fiscal externalities, but I perfer to use the direct/indirect terminology because some direct fiscal externalities are caused by benefit spillovers from the consumption of public goods, and some indirect fiscal externalities are not the result of changes in the consumption of public goods.

2. See Ballard and Fullerton (1992) for an introduction to the literature on the measurement and interpretation of the marginal cost of public funds.
3. See Bode, Krieger-Boden, and Lammers (1994) for a study of the impact of cross-border shopping between Denmark and Germany and Belgium and Germany.
4. See Wilson (1985, 1986, 1991), Zodrow and Mieszkowski (1986), Mintz and Tulkens (1986), Wildasin (1989), Bucovetsky (1991), Bucovetsky and Wilson (1991) and Hoyt (1991).
5. This assumes that the reduction in demand does not reflect inter-provincial smuggling which would lead to increased cigarette sales in other provinces and an offsetting increase in federal tax revenue.
6. See also Borge (1995) for a model where a vertical tax externality influences the provision of federal grants to state governments.
7. See Dickson, Milne, and Murrell (1995) for a study of the effect of provincial spending on university education on the revenue of the Canadian federal government.
8. This calculation is based on $\tau_i = 0$, $\epsilon = -0.953$, $\eta = 1.976$, $X_P = 1$, $X_p^i = 0.55$, $X_c = 0.65$ and $X_c^i = 0$.
9. See Wildasin (1989) for the derivation of the marginal subsidy rate when states impose taxes on capital which is perfectly mobile between states, but fixed for the country as a whole.
10. See also Wildasin (1984) and Ahmad and Stern (1987) on the equalizing the SMCF across governments.
11. See Boadway and Hobson (1993, 101–102) and Wildasin (1991) on the design of matching grants to correct benefit spillovers from states' income redistribution programs.
12. See Dahlby (1995) for a more detailed treatment of this issue.

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